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Research Article

Exploring the Preferences of Developed Value-Added Pigeon Peas-based Noodles and Instant Porridge among Different Consumer Segments in Rural Tanzania

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Abstract

Quantitative descriptive analyses for developed pigeon peas-based noodles (PPBN) and instant porridge (PIIP) has been done to quantify the perceived intensities of the sensory attributes. This does not inform about consumers' preferences of the product that is fundamental for sustainable consumption. Therefore, this study aimed at assessing the preferences of developed PPBN and PIIP products. A total of 162 consumers residing in Mitumbati and Mibure villages in Nachingwea and Ruangwa districts respectively, were involved. Data were analysed using SPSS, R software and Consumer checker software. About 46% of consumers were aged 25 - 49 years, 73% were female, married (70%), farmers (86%) and 77% had primary school education. The highest mean preference scores for colour, aroma and mouthfeel were observed in sample PPBN 718 and PIIPofspr. The correlation loadings indicated the overall liking of sample PPBN718 was related to colour and aroma whereas for sample PIIPofspr was related with mouthfeel, sweetness, colour and aroma attributes. Study revealed that colour, aroma and mouthfeel the key attributes for product preferences. It is recommended that consumers' preferences test should be considered during product development in order to come up with the best choice of product that will be acceptable among the intended consumers.

Keywords: Preferences, Pigeon Peas, Noodles, Instant Porridge Flour.

INTRODUCTION

Preference test for food attributes is very important to ensure the suitability and sustainability of a newly developed food products. The test determines the important criteria for food choice as well as consumer sensory perception of the developed products. The consumer behaviour theory assumes that a consumer is a rational economic agent aimed at attaining the highest possible satisfaction derived not only from the food itself but also from its attributes (Hanf & Winter, 2017). Consumers have tastes and preferences that determine their decision to accept or reject a food product. Hence for a product to be acceptable,

it should fit into consumers' preferences. Consumers decide how much should be spent in purchasing foods to maximize utility (Levin and Milgrom, 2004). Several factors may influence product acceptability including taste, quality and safety (Banterle et al., 2012). A conceptual model of food choice process over the life course revealed that experiences, social status, resources, sensory perceptions, quality, easy to use and nutritional benefits are some of the determinants for food choice among consumers which influence purchasing intention (Sobal et al., 2006). Based on the Theory of Reasoned Action (TRA), the consumer will perform the behaviour if she/he has a positive or negative attitude feeling towards a particular behaviour

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(Ajzen & Fishbein, 2005). Also, a consumer may accept a food product if she/he has feelings and rational decisions about the characteristics of the particular food product. Hence, analysing consumer preferences for developed pigeon peas-based noodles (PPBN) and instant porridge (PPIP) is an important stage that will help to determine the acceptability of product attributes.

Pigeon Peas-Based Noodles (PPBN) and Instant Porridge (PPIP) has been developed to address macro and micronutrients problems in Tanzania. Micronutrients deficiency is a serious public health problem, which affect growth and development of children (FAO et al., 2022). The deficiencies reduce work capacity among adults and increases chances for getting diseases (Tulchinsky, 2010). Micronutrient deficiencies can be reduced through several interventions including dietary improvement via consumption of enriched and diversified foods. The developed noodles and instant porridge has been enriched with pigeon peas which are rich in protein, vitamins and minerals and are expected to contribute at least 50% of daily nutritional requirement for protein, vitamin A, zinc and iron upon consumption of 100 g. This offers sustainable means of improving zinc, iron and vitamin A content of plant-based household meals. To ensure sustainable consumption, of developed products, testing their preferences is crucial to determine sensory qualities of the developed products that are culturally acceptable. Therefore, the study aimed at assessing the preferences of developed PPBN and PPIP products.

METHODOLOGY

The study was conducted in Mibure and Mitumbati villages in Ruangwa and Nachingwea districts respectively, in Lindi region. The two villages have been selected as they participated in previous study on development and testing sensory profile of pigeon peas-based noodles and instant porridge (Majili et al., 2023). A total of 162 untrained panellists (consumers) of different age groups including 22 school-aged children, 33 youth and 107 adults were invdolve to capture different preferences.

Study design

Incomplete Randomized Block Design (IRBD) was used to assess consumer preferences of the developed pigeon peas-based noodles (PPBN). This design was opted based on the fact that many samples of PPBN (eight samples) that were involved in the assessment, which was unable to present them to panellists in a single session. According to Lawless and colleague all samples should be served at once, but if not possible appropriate experiment plan such as incomplete block design should be used (Lawless & Hildegarde, 2010). Due to this, panellist evaluated four samples in first session and the other four samples were evaluated in the second session. Complete Randomized Block Design (CRBD) was

used to assess preferences of developed pigeon peas-based instant porridge (PPIP). This design was used as only four samples were assessed in a single session. Each sample of PPBN and PPIP was coded with three unique digit numbers to avoid biases. During testing, the samples (treatment) of PPBN and PPIP were randomly assigned to panellists (blocks) for testing.

A structured questionnaire was used to collect socio-demographic characteristics and preference ratings. Before the test, the study objective was explained to the panellists and their written consent was requested. All samples of PPBN and PPIP were cooked by selected mothers under the guidance of the main investigator in selected centres in the respective villages. PPBN samples were cooked by boiling in water until well cooked. An equal amount of cardamom, salt and sugar was added in the boiled noodles samples and mixed well before partially fried. A total of 162 untrained panellists in a group of 10 were allowed to sit for one test. Each panellist was served four samples at a time and requested to test and rate colour, aroma, mouthfeel, saltiness, softness and overall liking on a five-point scale. The rating score was 1 = extremely not preferred, 2 = less preferred, 3 = neither preferred nor preferred, 4 = preferred and 5 extremely preferred.

DATA ANALYSIS

Data were analysed using SPSS software version 25. Descriptive statistics (means, standard deviation and frequencies) were used to summarize consumer characteristics. R software (3.6.2 version) was used for descriptive analysis of preference scores of developed PPBN and PPIP samples in terms of colour, aroma, mouthfeel, sweetness, and overall acceptability. Analysis of variance (ANOVA) and post hoc pairwise test –Tukey HDS were used to compare means among samples at $p < 0.05$. Analysis of variance was also performed to check whether there was a significant difference among consumers' gender and age groups. Multivariate regression analysis was performed using Consumer checker software (2.3.1 version, Norway) to visualize the individual differences between consumers and their preference for sensory attributes of the developed pigeon peas-based products.

RESULTS

Socio-demographic Characteristics of Consumers Participated in the Preference Test

A total of 22 school-age children, 33 youth and 107 adults participated in the preference test. The mean age (years) of consumers was 11.05 ± 1.91 (SD) for consumers aged < 15 years, 20.7 ± 2.53 (SD) for consumers aged 15 - 24 years, 36.6 ± 6.63 (SD) for consumers aged 25 - 49 years, and 56.9 ± 6.82 (SD) for consumers aged > 49 years. About 46% were

aged between 25 - 49 years, 73% were female, 70% were married, 77% had attained primary school education and 86% were farmers (Table 1).

Consumer Preferences for Samples of Noodles (PPBN)

Table 2 presents results on the overall liking of developed PPBN. The overall liking of PPBN was differed significantly among the samples at $p < 0.05$. The overall mean of liking for sample PPBN193 was 4.5 ± 1.02 (SD), PPBN136 was 4.5 ± 1.08 (SD) and sample, PPBN718 was 4.5 ± 1.25 (SD). There was a significant difference among the sample and overall liking of colour, aroma, mouthfeel, saltiness and softness, with the lowest mean scores were observed in sample PPBN462 and PPBN475.

The means values with different superscript letters within a column are significantly different at $p < 0.05$.

Preference correlation loadings for PPBN in component 1 are explained by 62% in X- axis and 45% in Y- axis indicating

systematic variation among consumer liking of PPBN samples and drivers for their preference (Figure 1). The preference map indicated that more consumers were on the upper right of the plot and their preference was associated with products with high intensity for colour followed by the aroma. Preference for colour and aroma were associated with samples PPBN718, PPBN193 and PPBN136. Samples on the lower right part of the plot have high intensity for mouthfeel. The left upper part of the plot implies that, saltiness was less preferred and that characteristic was highly related to sample PPBN462.

Gender and Age Preferences in Rating PPBN

Results in (Table 3) indicated that there were significant differences in rating aroma, mouthfeel and softness for sample PPBN136 among males and females. The mean ranking for aroma was 53.9, mouthfeel (54.4) and softness (53.8) among females and that was higher than the ranking for the male counterparts. There were no significant differences between males and females in terms of overall liking of the samples. The

Table 1: Consumers' Socio-Demographic Characteristics.

Characteristics	n	%
Age		
<15 years	22	13.6
15 -24 years	33	20.4
25 - 49 years	76	46.9
> 49 years	31	19.1
Sex		
Female	118	72.8
Male	44	27.2
Marital status		
Married monogamous	113	69.8
Widowed/Divorced/ Single	27	16.7
Student	22	13.6
Education level		
no formal education	7	4.3
Primary school	125	77.2
In school	22	13.6
Secondary school	8	4.9
Occupation		
Farmer	140	86.4
Student	22	13.6

Table 2: Preference Scores For Noodles Samples.

Sample code	Colour $\bar{x} \pm SD$	Aroma $\bar{x} \pm SD$	Mouth Feel $\bar{x} \pm SD$	Saltiness $\bar{x} \pm SD$	Softness $\bar{x} \pm SD$	Overall Liking $\bar{x} \pm SD$
PPBN462	4.1±1.39 ^b	3.9±1.47 ^b	3.9±1.46 ^b	4.7±1.73 ^a	4.1±2.40 ^a	4.0±1.44 ^b
PPBN528	4.4±1.01 ^{ab}	4.3±1.04 ^{ab}	4.1±1.34 ^{ab}	4.3 ± 1.74 ^b	4.1±2.55 ^a	4.3±1.24 ^{ab}
PPBN858	4.3±1.27 ^{ab}	4.3±1.20 ^{ab}	4.1±1.26 ^{ab}	4.1±1.75 ^b	4.2±2.80 ^a	4.2±1.25 ^{ab}
PPBN718	4.5±1.07 ^a	4.4±1.28 ^a	4.3±1.28 ^a	4.1±1.9 ^b	4.2±2.25 ^a	4.4±1.25 ^{ab}
PPBN475	4.2±1.21 ^{ab}	4.0±1.31 ^{ab}	3.9±1.40 ^b	4.4±1.42 ^{ab}	4.1±1.98 ^a	4.1±1.37 ^{ab}
PPBN193	4.5±0.85 ^a	4.4±0.99 ^a	4.4±1.10 ^a	4.06±1.61 ^b	4.4±2.08 ^a	4.5±1.02 ^a
PPBN136	4.5±1.04 ^a	4.4±1.17 ^a	4.4±1.11 ^a	4.1±1.15 ^b	4.2±2.06 ^a	4.5±1.08 ^a
PPBN267	4.3±1.31 ^{ab}	4.3±1.32 ^{ab}	4.1±1.50 ^{ab}	4.1±1.72 ^b	3.8±2.50 ^a	4.3±1.45 ^{ab}

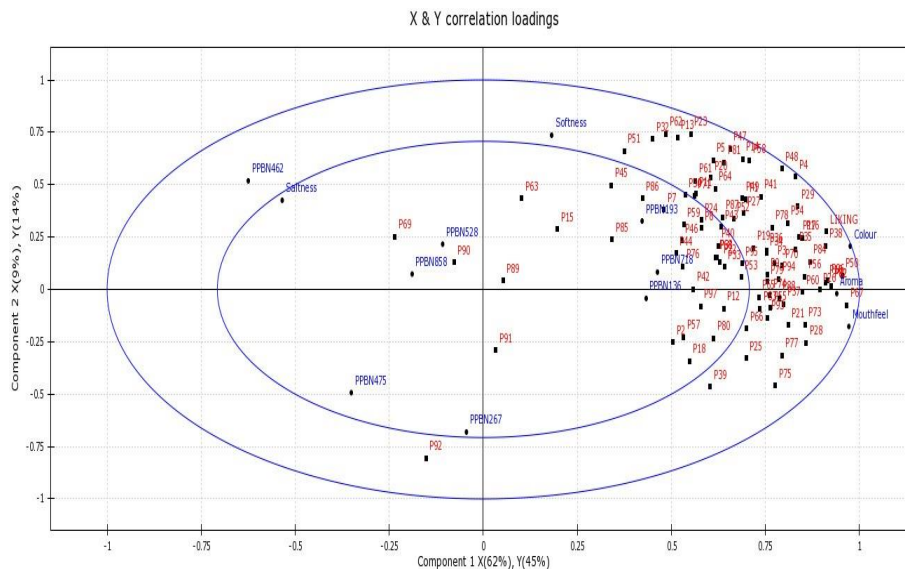


Figure 1: Preference Loadings For PPBN.

Table 3: Preferences For Noodles Samples (PPBN) By Gender.

Sample	Sex	N	Colour		Aroma		Mouth Feel		Saltiness		Softness	Overall Acceptability		
			X Rank	p-Value	X Rank	p-Value	X Rank	p-Value	X Rank	p-Value	p-Value	X Rank	p-Value	
PPBN136	F	54	52.0	0.08	53.9	0.01*	54.4	0.00*	52.0	0.08	53.8	0.00*	49.2	0.73
	M	42	44.1		41.6		41.0		44.0		41.7			
PPBN193	F	54	49.6	0.55	50.8	0.26	50.6	0.30	50.8	0.25	49.3	0.67	49.5	0.59
	M	42	47.1		45.6		45.8		45.6		47.5			
PPBN267	F	54	51.8	0.09	51.5	0.14	51.1	0.21	51.5	0.15	51.6	0.10	48.2	0.88
	M	42	44.3		44.7		45.1		44.7		44.5			
PPBN462	F	54	47.8	0.73	48.3	0.93	46.6	0.38	47.8	0.76	48.6	0.96	45.4	0.13
	M	42	49.4		48.7		51.0		49.4		48.4			
PPBN475	F	54	50.9	0.26	48.6	0.96	51.7	0.17	51.2	0.22	52.5	0.07	49.7	0.57
	M	42	45.4		48.4		44.5		45.0		43.3			
PPBN528	F	54	51.3	0.21	51.8	0.14	50.0	0.51	50.5	0.39	53.4	0.01*	44.1	0.05
	M	42	44.9		44.2		46.6		45.9		42.1			
PPBN718	F	54	50.0	0.48	52.0	0.09	50.0	0.48	50.6	0.29	50.9	0.24	47.1	0.46
	M	42	46.6		44.0		46.6		45.8		45.5			
PPBN858	F	54	48.3	0.91	50.7	0.35	49.7	0.59	49.6	0.64	52.8	0.05	46.3	0.33
	M	42	48.8		45.7		46.9		47.1		42.9			

\bar{x} Rank = mean rank

significant differences were also observed in rating softness for sample PPBN528 whereas female rank the highest than male counterparts. There were no significant differences in rating other samples (PPBN193, PPBN267, PPBN462, PPBN718, PPBN475, PPBN858) among male and females.

Results in Table 4 show that, there was no significant difference in the overall liking scores and consumers age.

However, significant difference was observed in mouthfeel for sample PPBN462 whereas the mean rank of 56.69 was observed among consumers aged above 49 years followed by 49.09 for consumers who are aged below 15 years. There was no significant difference in mean ranking among consumers' marital status, occupation and education level.

Consumer Preferences for Developed PPIP

For develop PPIP, there was a significant difference in colour, aroma, and mouthfeel between samples with pumpkin

flour (PPIP^r and PPIP^b) and those with orange fleshed sweet potatoes flour (PPIP^r and PPIP^b) at $p < 0.05$. All samples were similar in terms of sweetness. The average overall liking of PPIP was 4.9 ± 0.29 (SD) for sample PPIP^r and 4.9 ± 0.25 (SD) for sample PPIP^b (Table 5). Overall liking was significant difference between samples with blanched pigeon peas (PPIP^b and PPIP^b) and roasted pigeon peas (PPIP^r and PPIP^r) at $p < 0.05$.

The means values with different superscript letters within a column are significantly different at ($p < 0.05$).

The correlation loadings for PPIP samples indicate that component 1 was explained by 83% and 71% of variations of the X and Y axis (Figure 2). The overall liking of the sample on Y-axis was related to colour, aroma, mouthfeel, and sweetness, which were closer to sample PPIP^r and PPIP^b. however, in the X-axis the overall liking was related

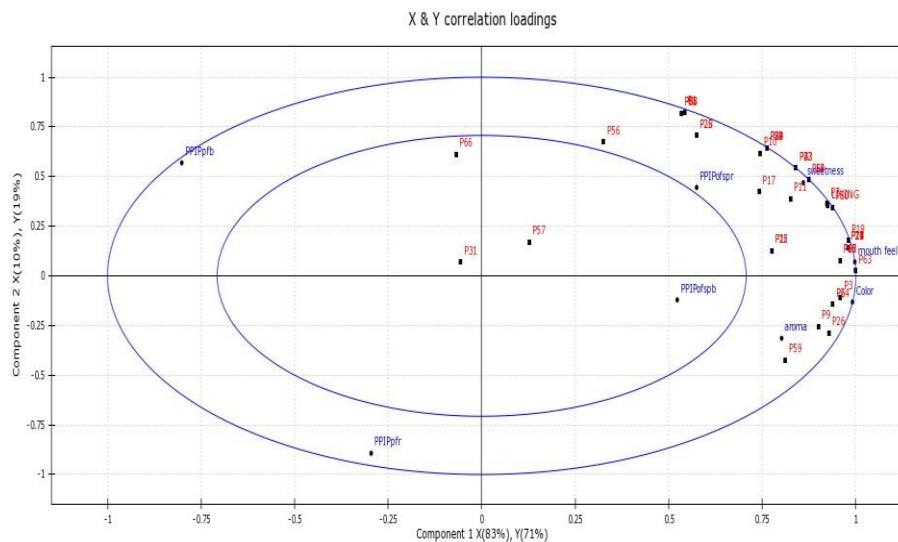
Table 4: Preferences For Noodles Samples (PPBN) By Age.

Sample	Age (years)	Colour		Aroma		Mouthfeel		Saltiness		Softness		Overall liking	
		X Rank	p-Value	X Rank	p-Value	X Rank	p-Value	X Rank	p-Value	X Rank	p-Value	X Rank	p-Value
PPBN136	< 15	51.3		49.3		49.6		44.7		50.6		42.9	
	15 - 24	40.2	0.48	48.5	0.98	51.5	0.91	50.7	0.66	52.5	0.71	40.4	0.15
	25 - 49	50.4		49.2		46.5		47.2		45.4		51.5	
	> 49	47.8		47.0		48.7		52.2		48.8		53.2	
PPBN193	< 15	46.6		41.0		45.5		44.4		45.9		46.3	
	15 - 24	49.1	0.23	53.2	0.33	44.2	0.54	51.9	0.46	50.6	0.57	42.6	0.59
	25 - 49	44.2		49.3		48.0		46.2		45.9		51.1	
	> 49	55.2		51.4		53.6		53.1		52.8		49.9	
PPBN267	< 15	51.6		48.4		48.1		48.9		50.4		46.6	
	15 - 24	39.1	0.40	46.6	0.97	44.9	0.92	44.3	0.91	44.8	0.89	52.3	0.88
	25 - 49	49.4		49.8		50.2		48.8		49.2		47.9	
	> 49	49.4		47.7		48.4		49.7		47.8		48.9	
PPBN462	< 15	46.5		48.2		49.1		51.5		50.8		51.9	
	15 - 24	42.5	0.36	33.5	0.08	32.5		34.3	0.09	46.9	0.71	44.4	0.74
	25 - 49	46.9		49.4		47.7	0.04*	47.0		45.2		49.7	
	> 49	54.9		54.8		56.7		54.8		51.5		46.2	
PPBN475	< 15	52.9		51.0		48.8		52.0		48.3		41.9	
	15 - 24	41.5	0.40	50.7	0.19	42.9	0.48	42.6	0.31	50.6	0.71	42.9	0.21
	25 - 49	45.6		41.4		45.7		44.0		44.9		49.3	
	> 49	51.9		54.3		54.4		54.1		52.2		55.5	
PPBN528	< 15	51.2	0.18	44.9	0.05	54.2		46.6	0.91	47.5	0.10	53.0	0.46
	15 - 24	39.2		39.7		44.0	0.40	47.5		55.6		41.9	
	25 - 49	54.2		58.2		50.7		51.2		53.3		45.6	
	> 49	43.6		43.4		43.3		47.2		39.9		51.8	
PPBN718	< 15	52.7		40.0		54.2		44.5		45.1		49.1	
	15 - 24	40.3	0.14	43.5	0.06	44.0	0.40	45.3	0.49	45.4	0.45	50.0	0.45
	25 - 49	44.1		48.9		50.7		48.2		47.3		44.1	
	> 49	54.5		57.4		43.3		53.7		54.3		52.9	
PPBN858	< 15	49.6		51.7		48.0		45.5		43.0		51.5	
	15 - 24	43.6	0.90	51.5	0.83	49.3	0.50	57.9	0.21	48.4	0.57	38.3	0.12
	25 - 49	49.0		46.0		44.1		43.0		52.5		44.5	
	> 49	49.4		47.6		54.2		53.4		48.0		56.0	

\bar{x} Rank = mean rank

Table 5: Mean Preference Scores For PPIP.

Sample	Colour $\bar{x} \pm SD$	Aroma $\bar{x} \pm SD$	Mouth feel $\bar{x} \pm SD$	Sweetness $\bar{x} \pm SD$	Overall Liking $\bar{x} \pm SD$
PPIP _{pf} ^b	4.7±0.91 ^{ab}	4.5±0.98 ^{ab}	4.5±0.95 ^{ab}	4.7±0.70 ^a	3.7±0.94 ^c
PPIP _{pf} ^r	4.7±0.02 ^b	4.2±1.22 ^b	4.1±1.30 ^b	3.9±1.56 ^a	3.7±0.94 ^c
PPIP _{ofsp} ^b	4.0±0.09 ^{ab}	4.8±0.41 ^a	4.9±0.35 ^c	4.8±0.48 ^a	4.8±0.85 ^b
PPIP _{ofsp} ^r	4.9±0.29 ^a	4.8±0.42 ^a	4.8±0.49 ^c	4.9±0.35 ^a	4.9±0.29 ^a

**Figure 2:** Preference Loadings Of Developed PPIP.

to sweetness and mouthfeel for sample PPIP_{ofsp}^r in the upper right hand; as well as colour and aroma for sample PPIP_{ofsp}^b in the lower right hand. The variations in component 2 were explained by 10% and 19% of X and Y loadings, respectively that were related to samples PPIP_{pf}^b and PPIP_{pf}^r indicating little association between consumer liking and product attributes.

DISCUSSION

There was no statistical significance in ranking the PPBN samples in terms of colour, aroma and mouthfeel in relation to consumers' education, marital status and occupation. However, a significant difference was observed in ratings for aroma, mouthfeel and softness of PPBN136 among female and male consumers. Female consumers had higher mean rating scores than their male counterpart. This could be due to the high sensitivity of females in rating food products compared to males which was attributed to gustatory function as reported earlier (Miyagi, 2017).

The differences were also observed in ratings for mouthfeel among different consumer age groups. The higher mean rating scores were observed among consumers aged above 49 years and those who were less than 15 years old. This could be due to differences in consumption behaviour between consumer groups, influenced by neuro-muscular

activities that contribute to chewing behaviour. A mouthfeel was associated with the slippery of food in the mouth; hence chewing for a long time makes the taste and texture well perceived. Prolong chewing also makes the food softer and slippery. As age of the person advances the chewing ability decreases hence lengthening the process and consequently enhance the slippery feel for the food (Locker, 2002).

Despite gender and age differences, samples PPBN718, PPBN193 and PPBN136 were the most preferred in terms of colour aroma and mouthfeel. This was attributed to the type of ingredients used; samples PPBN718 and PPBN193 were composed of higher proportion of wheat flour (60%) compared to the other samples. Wheat flour dilutes the deep colour of pigeon flour and making the product resemble the colour of most the wheat-based noodles. Despite sample PPBN136 having 64% of PP addition of OFSP flour makes its colour look similar with sample PPBN193 which has also composed of OFSP flour.

For pigeon peas-based instant porridge, the samples composed of pigeon peas, maize and orange fleshed sweet potato flour (PPIP_{ofsp}^r and PPIP_{ofsp}^b) had higher mean intensity scores indicating most preferred one. Preference for the two samples (PPIP_{ofsp}^r and PPIP_{ofsp}^b) were also associated with colour, aroma, mouthfeel, and sweetness. This was due to the colour and aroma of OFSP which was light

yellow compared to the samples composed of pumpkin flour (PPIP_{pf}^b and PPIP_{pf}^r). Pumpkin flour had a strong aroma that changed the grain taste for the blended flour. The developed porridge flour (PPIP_{pf}^b and PPIP_{pf}^r) blend had 26% of pumpkin flour compared to 15% of OFSP contained in samples PPIP_{ofsp}^r and PPIP_{ofsp}^b. This amount could be high enough to alter the taste of the instant porridge (PPIP) from the flour blend; consequently, samples PPIP_{pf}^b and PPIP_{pf}^r scored less in sensory attributes compared to samples PPIP_{ofsp}^r and PPIP_{ofsp}^b. It has been reported that food products blended with pumpkin had less preferred colour, reduced taste preference and low level of acceptability (Yuliantini *et al.*, 2020; Minarovičová *et al.*, 2017).

Regarding correlation loadings for sample PPIP_{ofsp}^r was related to sweetness and mouthfeel whereas sample PPIP_{ofsp}^b was associated with colour and aroma. Sample PPIP_{ofsp}^r was composed of maize flour, roasted pigeon peas and OFSP flour. It was likely that the sweetness observed was associated with natural sugar available in OFSP. Similar findings were reported earlier (Ukom *et al.*, 2019) that sugar available in OFSP flour has great influence on acceptability of taste and flavour. The mouthfeel experienced by consumers was due to the coffee or chocolate taste feel available in the roasted pigeon peas. The roasted pigeon peas made the flour blend looks a little bit dull in colour compared to the sample of PPIP_{ofsp}^b which was composed of blanched pigeon peas. This made sample PPIP_{ofsp}^r to be highly associated with the preferred colour of the porridge. Sample PPIP_{ofsp}^r was also highly associated with good aroma compared to sample PPIP_{ofsp}^b. This could be due to the Maillard reaction that occurs during the roasting of PP. It has been reported that Maillard reaction influences the colour, texture and aroma of different foods products (Starowicz & Zieliński, 2019).

CONCLUSIONS AND RECOMMENDATION

The study revealed that the preferences of developed pigeon peas-based noodles (PPBN) and instant porridge (PPIP) among different consumers were influenced by colour, aroma and mouthfeel. The developed noodles (PPBN718) and instant porridge (PPIP) if consumed frequently at the required amount, will help to improve iron, zinc and vitamin A status among children. Understanding consumer preference of developed products will assist in the developments of custom-made products that fulfil the diverse needs and tastes of consumers. This will lead to increased adoption and consumption of the developed products that are nutrient dense for the wellbeing of the individual. It is recommended that consumers' preferences tests should be taken into account during product development in order to come up with the best choice of product that will be acceptable among the intended consumers.

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Declaration Of Conflicting Interests

The authors declare that there is no conflict of interest

Author Contributions: Z.S.M. countersigned on the design of the study, data collection, and performed the statistical analysis; as well as writing the first draft of the manuscript. Other author (C.N., K.K., K.M., C.R. and S.S.) critically reviewed and refined the manuscript and provided close supervision. All authors have read and agreed to the published version of the manuscript.

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